1060-3.

ƙ OIL HEATERS
ƙ FEED WATER HEATERS

SCHUTTE & KOERTING COMPANY

MAIN OFFICE AND WORKS, PHILADELPHIA

Branch Offices and Sales Agents in All Leading Cities

Heat Transfer Catalog
Pages 10201 to 10216

BULLETIN NO. 10-F

January, 1938

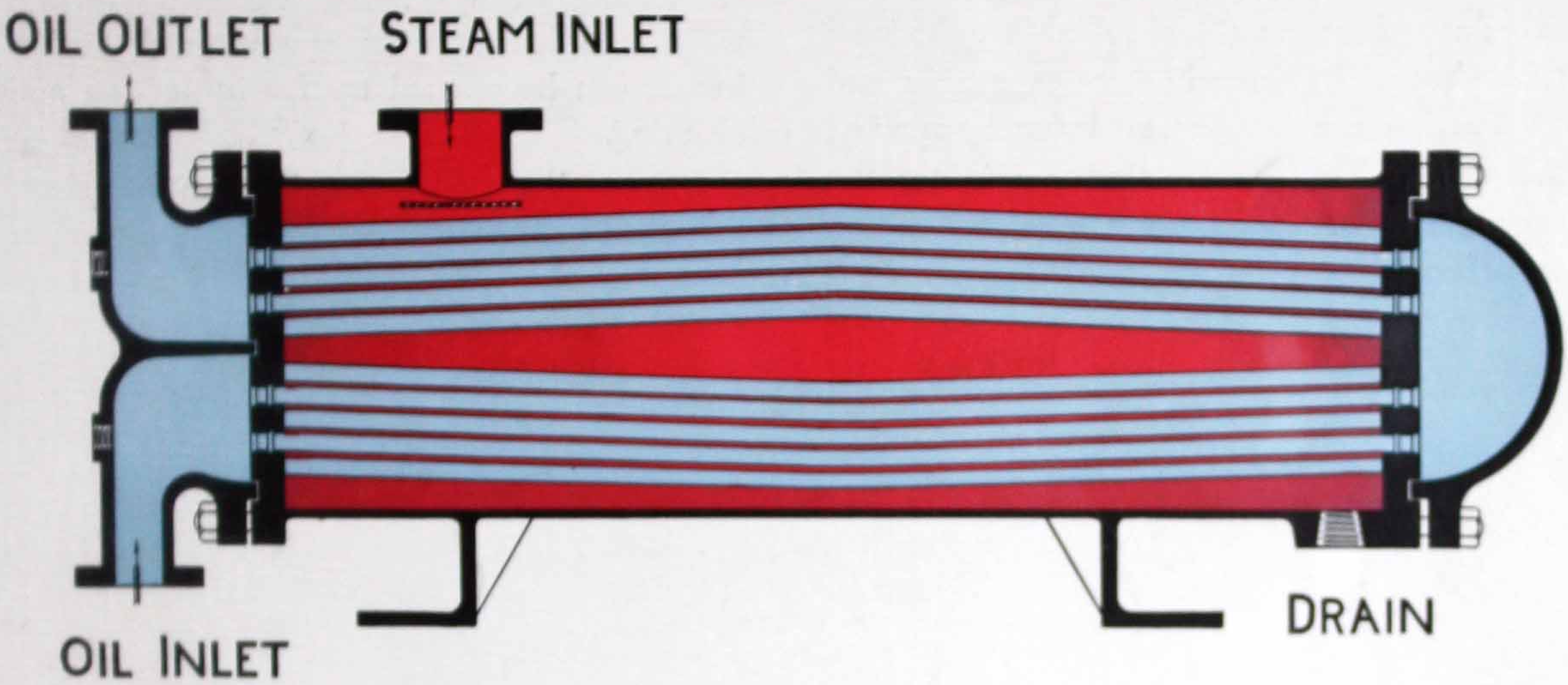


FIG. 1065-A. ƙ OIL HEATER

Red is used for steam, blue for oil

THE ƙ Fuel Oil Heater, illustrated in Fig. 1065-A, is designed for use with high pressure steam and heavy oils. With low pressure steam large quantities of light oils are rapidly heated to the proper temperature. This heater is of tubular construction, the main shell being plate steel. The upper and lower tube sheets are of steel and are rigidly secured to the end of the heater shell. The oil inlet and outlet header is connected to the upper tube sheet by means of studs, and the lower cover is attached to the bottom tube sheet in like manner. The steam inlet is on the side near the top, the condensate outlet being on the heater shell near the bottom flange. A horizontal baffle plate is provided inside the shell near steam inlet, to prevent live steam from blowing directly against the

tubes at this point and to give a more even distribution of the steam through the tube bundle.

This heater is of multi-pass design, the oil flowing through the tubes, the steam across the tubes. Vertical partitions in the upper and lower headers divide the tube bundle in proper manner to produce flow through the tubes in several passes. Due to the long oil travel a full heating effect is obtained. The tubes are of seamless steel rolled into the steel tube sheets. In these heaters expansion and contraction are compensated for by bowing the tubes. The construction eliminates the special sliding headers or stuffing-boxes that would otherwise be required with straight shells.

Removal of top header makes the tube bundle accessible for inspection and cleaning.

Fuel Oil Burning auxiliary equipment is frequently installed in duplicate, in order to prevent any interruption in service, and Fuel Oil Heaters can be connected up in a twin arrangement by the use of valves and 3-way cocks in the steam and oil lines. In such cases each heater should be of sufficient size to handle the total amount of oil, the connecting fittings being arranged so that when one heater is in operation the other heater can be opened up for inspection and cleaning.

Fuel Oil Heaters are built in various sizes, ranging in capacity from 1000 lbs. of oil per hour upward. The principal dimensions are given on opposite page. Prices on application.

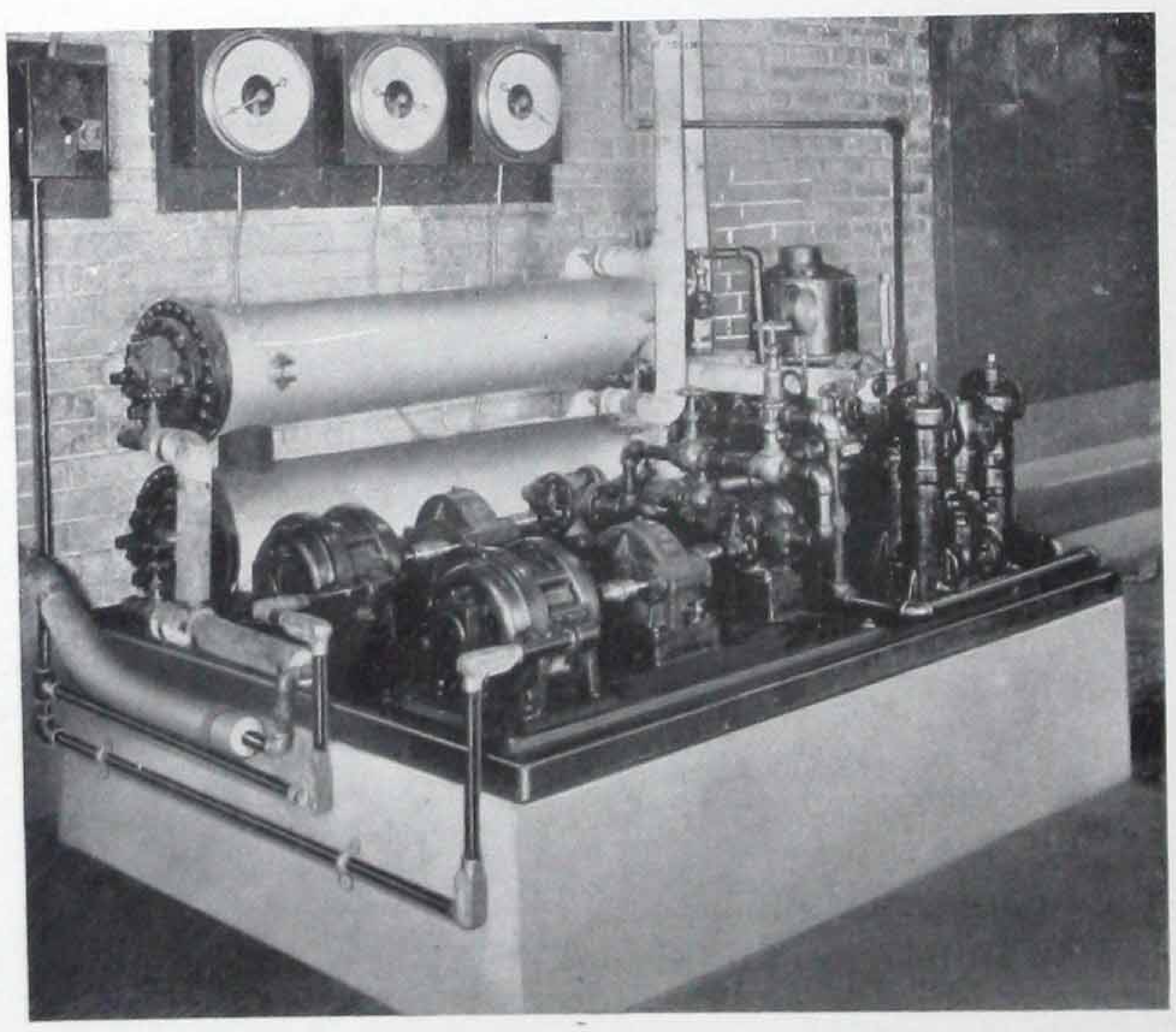


FIG. 6565— PUMPING OUTFIT WITH DUPLEX OIL HEATERS

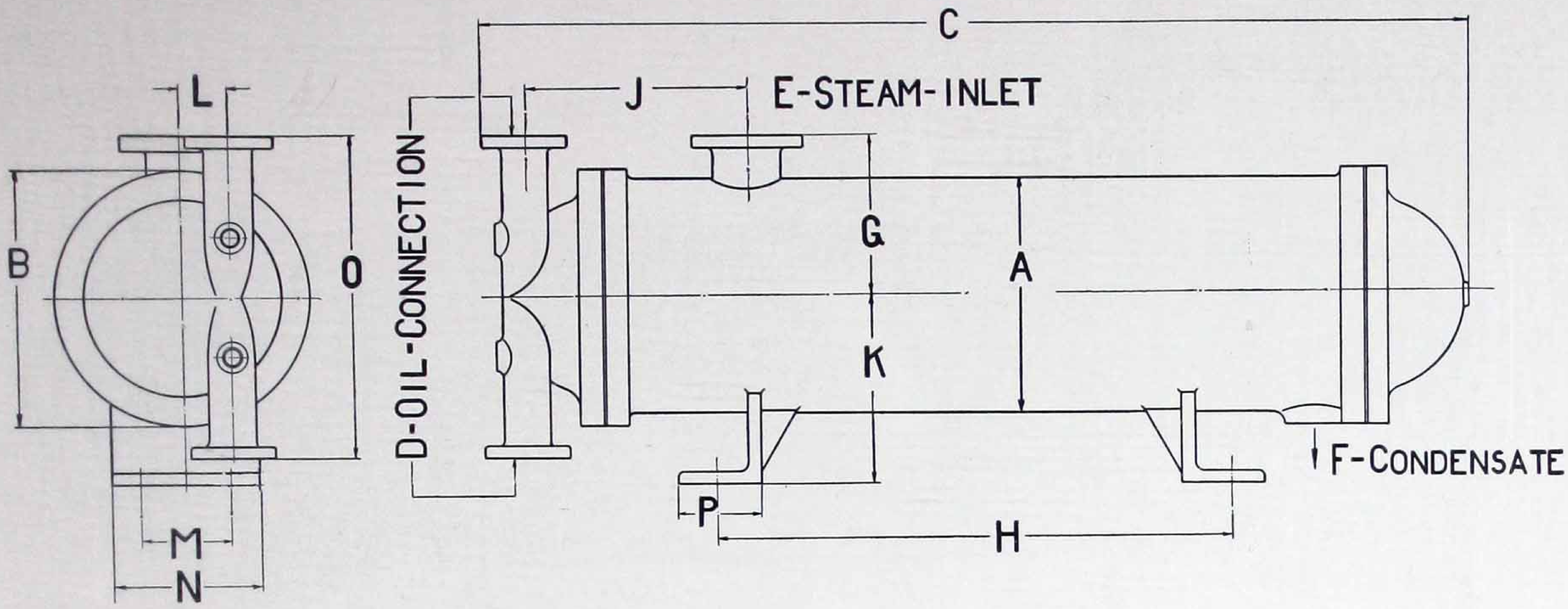


FIG. 1065-C. PRINCIPAL DIMENSIONS OF FUEL OIL HEATER

DIMENSIONS OF FUEL OIL HEATER, FIG. 1065-C

No.	Wt. Lbs.	DIMENSIONS, INCHES														
		A	B	C	D	E	F	G	H	J	K	L	M	N	O	P
18	325	7⅝	8½	64 3/16	¾ (scr.)	¾ (scr.)	½ (scr.)	....	47¼	17⅜	7	1½	3½	6	....	3
36	425	9⅝	10½	65¼	1 (scr.)	¾ (scr.)	½ (scr.)	....	47¼	17 9/16	8	1⅞	3½	6	....	3
60	650	11¾	12½	68 13/16	1½	1 (scr.)	½ (scr.)	....	47¼	18⅝	9 1/16	1⅞	3½	7	16½	3½
78	1000	12¾	14½	69⅝	1½	1½	¾ (scr.)	9¼	47¼	18¾	9⅜	2¼	5	8	17	4
102	1375	14	16¾	71¾	1½	1½	¾ (scr.)	11	46	18¾	10	3	6	9¾	20½	3½
132	1700	16	18½	72⅞	2	2	1¼ (scr.)	12	45	18¾	11⅜	3¼	7	11¾	22	4
168	2000	20	22½	73 13/16	2½	2	1¼ (scr.)	14	45	18¾	13½	3½	8½	13¼	25½	4
254	3000	22	24	78⅛	2½	2	1¼ (scr.)	15½	45	18¾	14	4	10	15	26½	5

Oil, Steam and Drain Connections are 250 lb. Std. A. S. M. E.

DOUBLE TUBE SHEET FUEL OIL HEATER

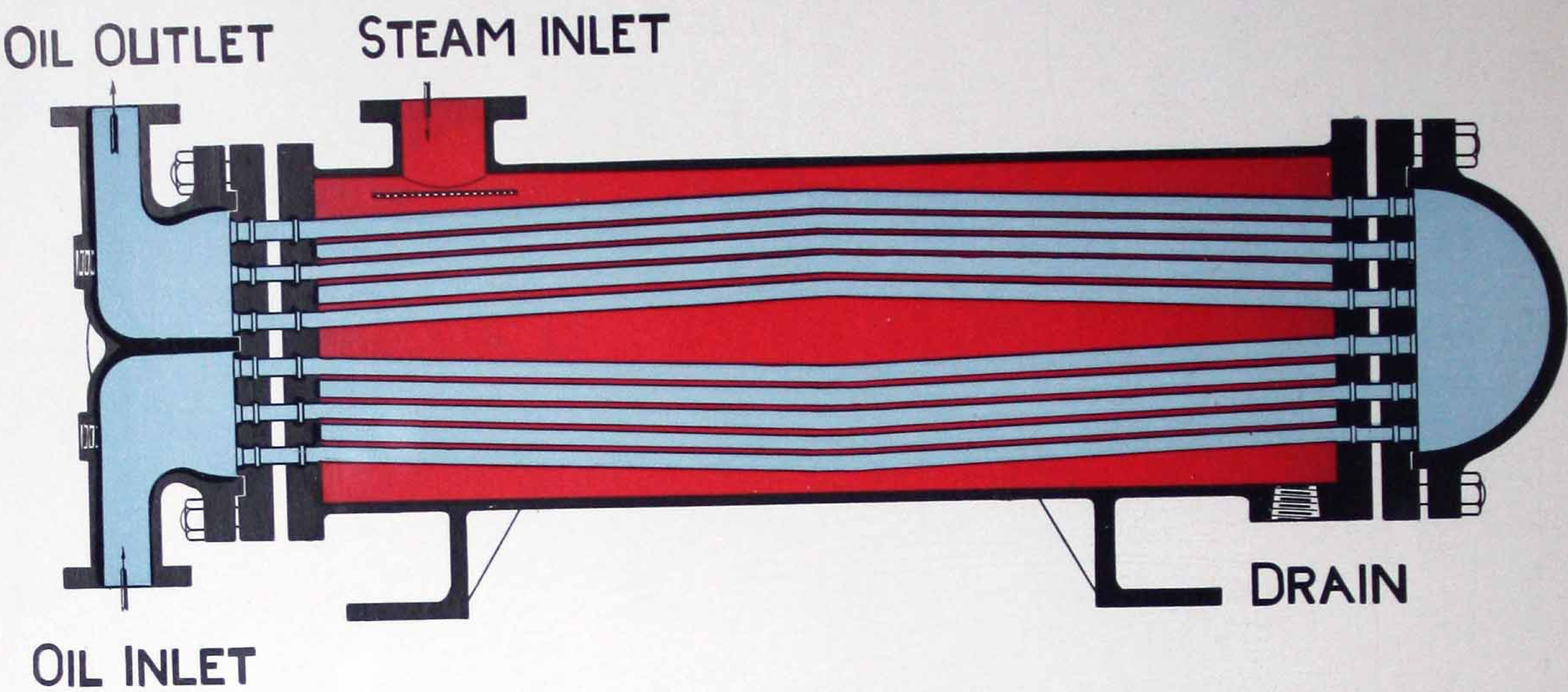


FIG. 1065-D. FUEL OIL HEATER WITH DOUBLE TUBE SHEETS
Red is used for steam, blue for oil

THE possibility of fuel oil leakage into the steam space is entirely eliminated with the double tube sheet design, and this construction is particularly desirable when very high pressure steam is used. You will note from the design that the steam compartment is entirely separate from the oil containing compartment, and in case of any slight leakage through the tube holes in the tube sheets, either on the steam or oil side, it is communicated to the outside due to space provided between each pair of tube sheets. In this design the tube is rolled into both tube sheets. The tube holes in each tube sheet being provided with parallel grooves so that the tubes are anchored securely into the tube sheets.

ƙ COIL TYPE OIL HEATER

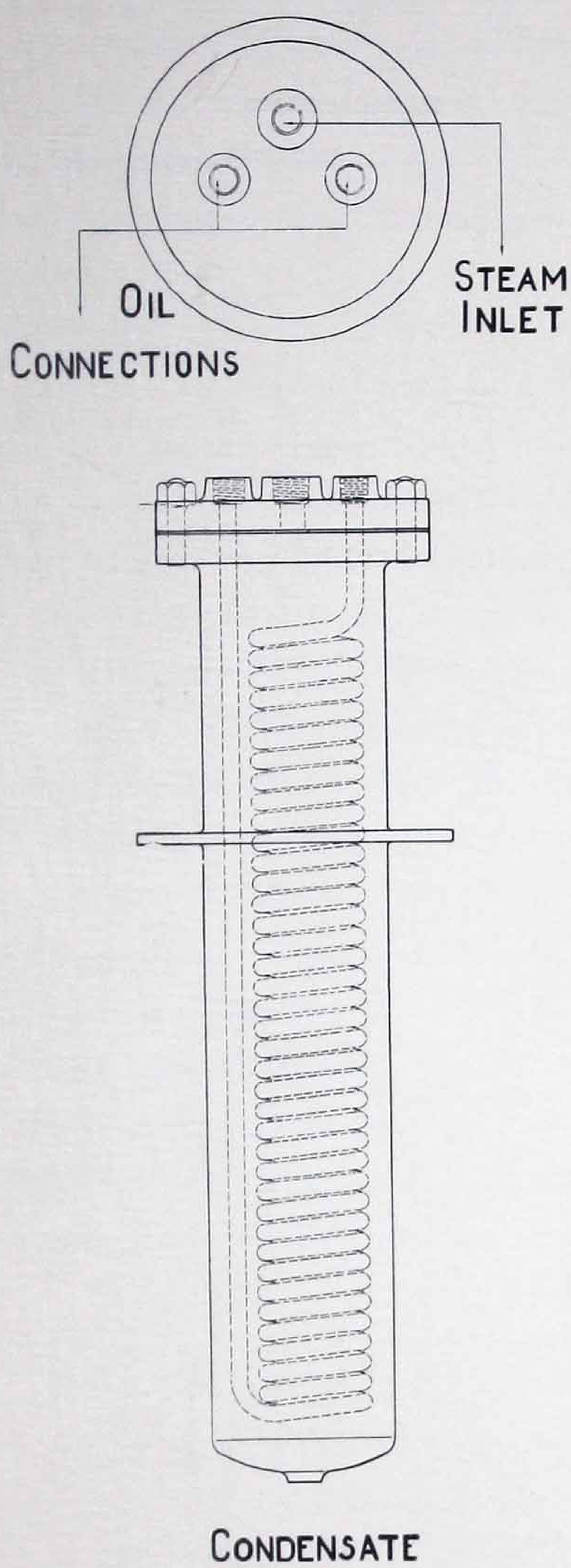


FIG. 1066. ƙ SINGLE COIL TYPE OIL HEATER

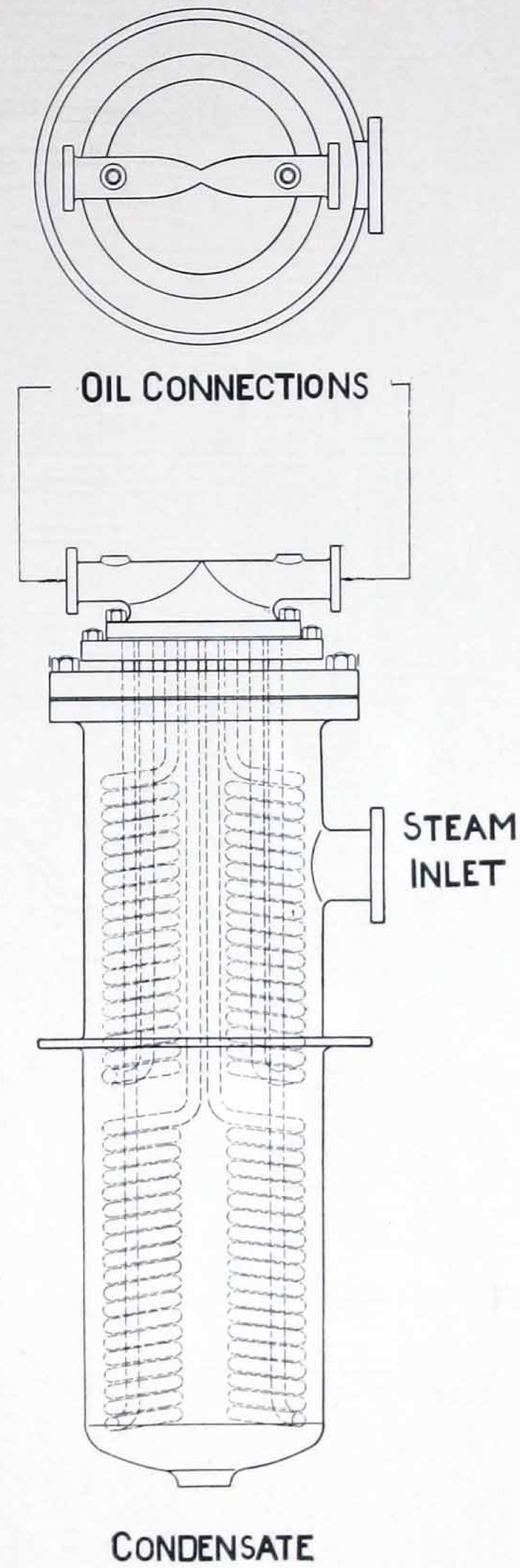


FIG. 1067. ƙ MULTI-COIL TYPE OIL HEATER

Should coil type Oil Heaters be desired, they can be furnished, as shown in the above cuts, either with single or double tube sheets.

In this type of heater the oil flows through the tubes, therefore cleaning is done with a solvent. This type is used especially for small capacities.

SINGLE UNIT ELECTRIC OIL HEATER

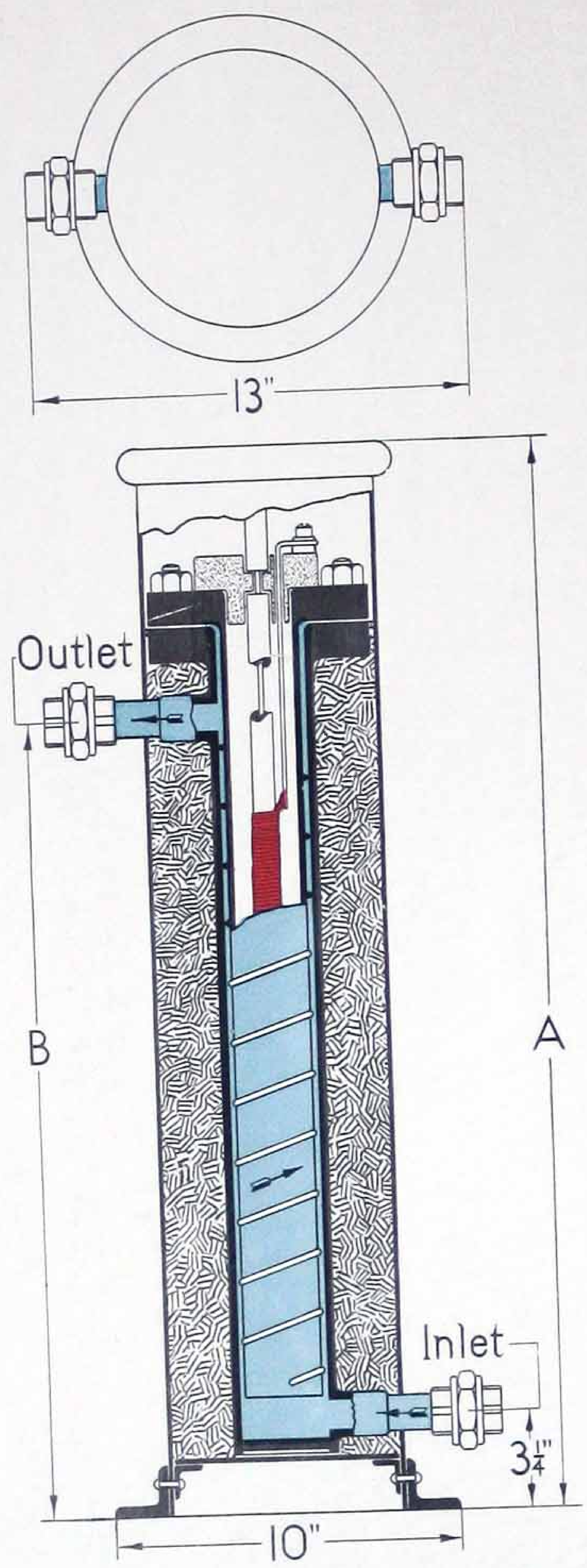


FIG. E-110. SINGLE UNIT ELECTRIC HEATER

THE construction of the Single Unit Heater is shown in Fig. No. E-110. A sheet steel shell, which is bolted to a steel base, encloses a tube section consisting of an electric heating element surrounded by two concentric, seamless, steel tubes with ¼" clearance between them. Around the inner tube is spiraled a ¼" iron wire which acts as a partition and forms a spiral channel between the tubes. The liquid enters through the inlet at the base and is forced into a thin film which passes through the channel formed by the iron wire for a distance of about three times the length of the tube. The liquid is subjected to a continuous, uniform heat, and, consequently, its temperature is raised very rapidly. The heated liquid passes out through the outlet at the top. The electric heating element is of high-grade nichrome wire wound on a porcelain tube. It is attached to the cover of the tube section by a stoneware flange and can be readily removed without disconnecting any piping. Holding guides support the heating element in the center of the inner tube and prevent breakage. The entire Heater is packed with mineral wool to prevent heat loss.

CAPACITIES, DIMENSIONS AND PRICES OF SINGLE UNIT HEATER, FIG. E-110

Capacity K.W.	Current Characteristics	Voltage	Oil Connections	Dimensions (Inches)		Approx. Weight	List Price
				A	B		
½	D. C. or Single ph. A. C.	110, 220	½" Screwed	23	16	60 lbs.	$ 90.00
1	D. C. or Single ph. A. C.	110, 220	½" Screwed	32	25	80 lbs.	110.00
2	D. C. or Single Ph. A. C.	110, 220	½" Screwed	38	31	100 lbs.	125.00

TRIPLE UNIT ELECTRIC OIL HEATER

FOR larger installations requiring Heaters of 5 K.W. to 12½ K.W. capacity, the B.C. Triple Unit Electric Heater provides the same rapid and efficient heating as the smaller Single Unit Type described on page 10206.

This Triple Unit type can be used advantageously wherever the rapid heating of heavy liquids in large quantities is desired, such as when starting up fuel oil burning systems, etc.

The construction of the Triple Unit Heater is shown in Fig. No. E-111. It is similar to the Single Unit Type, except that three tube sections are provided. The principle of operation is the same—the liquid enters through the inlet at the base, passes in a thin film up the spiral channel formed by the ¼″ iron wire between the two seamless steel tubes, but in the Triple Unit Type the three tube sections are so connected that the liquid flows from the top of first section down the second, up the third and is discharged, heated through the outlet at the top of the third section.

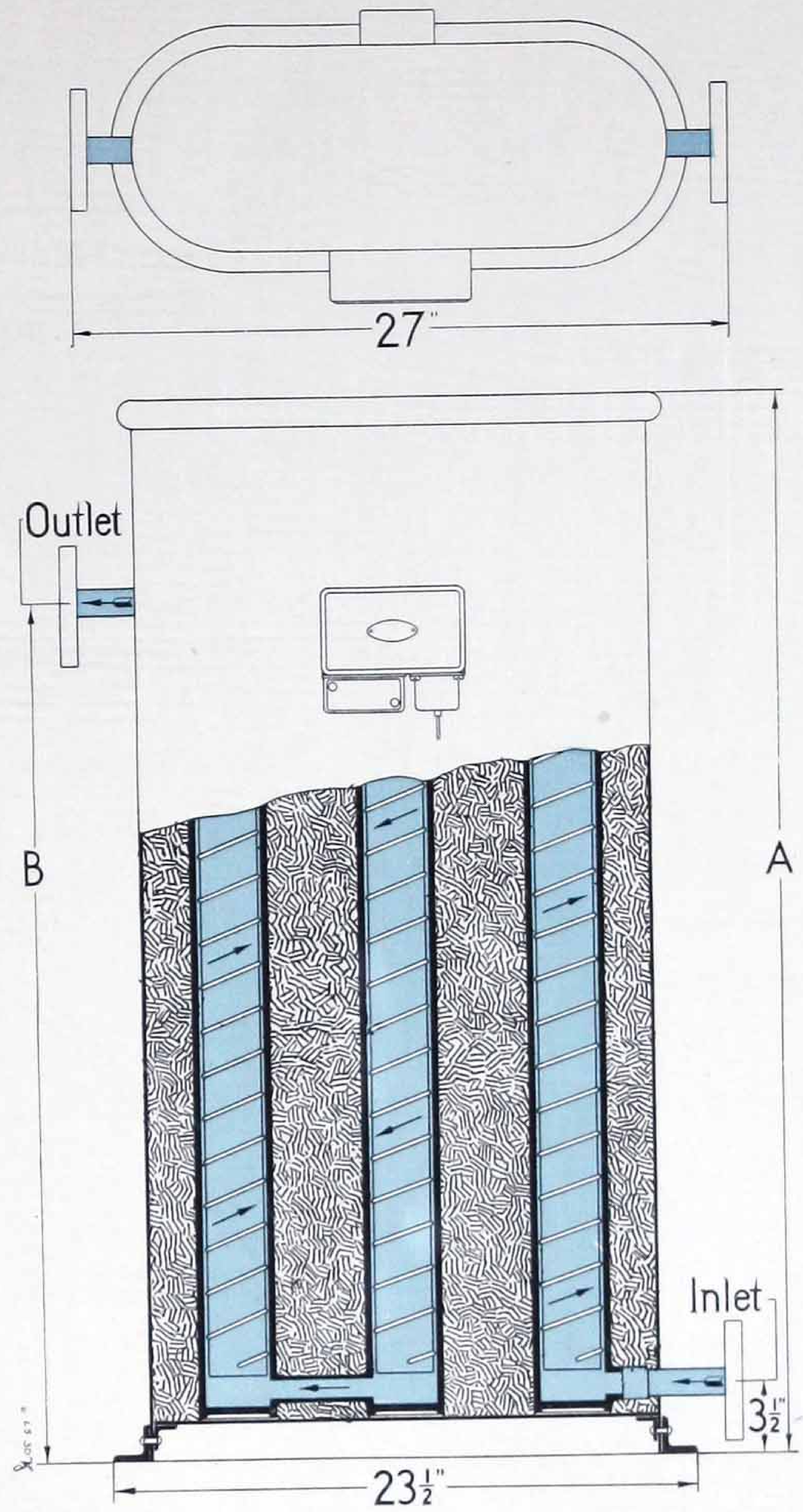


FIG. E-111. TRIPLE UNIT ELECTRIC HEATER

CAPACITIES, DIMENSIONS AND PRICES OF TRIPLE UNIT HEATER, FIG. E-111

Capacity K.W.	Current Characteristics	Voltage	Oil Connections	Dimensions (Inches) A	Dimensions (Inches) B	Approx. Weight	List Price
5	D. C. or Single & 3 ph. A. C.	220, 440	½″ Flanged	35	28	220 lbs.	$250.00
7½	D. C. or Single & 3 ph. A. C.	220, 440	¾″ Flanged	41	34	260 lbs.	305.00
10	D. C. or Single & 3 ph. A. C.	220, 440	¾″ Flanged	54	47	310 lbs.	347.00
12½	D. C. or Single & 3 ph. A. C.	220, 440	¾″ Flanged	60	53	350 lbs.	382.00

HEATING FUEL OIL

FUEL oil is preheated in order to reduce the viscosity and therefore to assist the atomization of the oil in oil burning equipment.

There is no practical gain in heating the oil above the temperature corresponding to a viscosity for which the atomizers produce efficient atomization. This viscosity usually is 4 Engler. In the case of the more viscous oils, care should be taken that the oil is not heated above the flash point. Unless leaks in the oil lines are guarded against, excessive preheating to reduce viscosity would be a dangerous expedient. A temperature of 300°F. is frequently sufficient for fine atomization of the heaviest oils and for their complete and perfect combustion in the boiler furnace.

For proper atomization, the oil should be preheated to the temperature given below.

PRE-HEATING TEMPERATURES FOR FUEL OIL (Approximate)

Degrees Baume	Specific Gravity 60°/60°F.*	Temperature Deg. Fahr.
12.0	0.9859	250
16.0	0.9589	220
20.0	0.9333	200

*Indicates that the sp. gr. of the oil at 60° F. is referred to water at 60° F. as unity.

Live steam is the usual heating agent, because sufficiently high oil temperatures cannot be secured with exhaust steam.

The Fuel Oil Heater for a given installation should have, under all conditions, a sufficient capacity to handle at full load the heaviest oils that will have to be used.

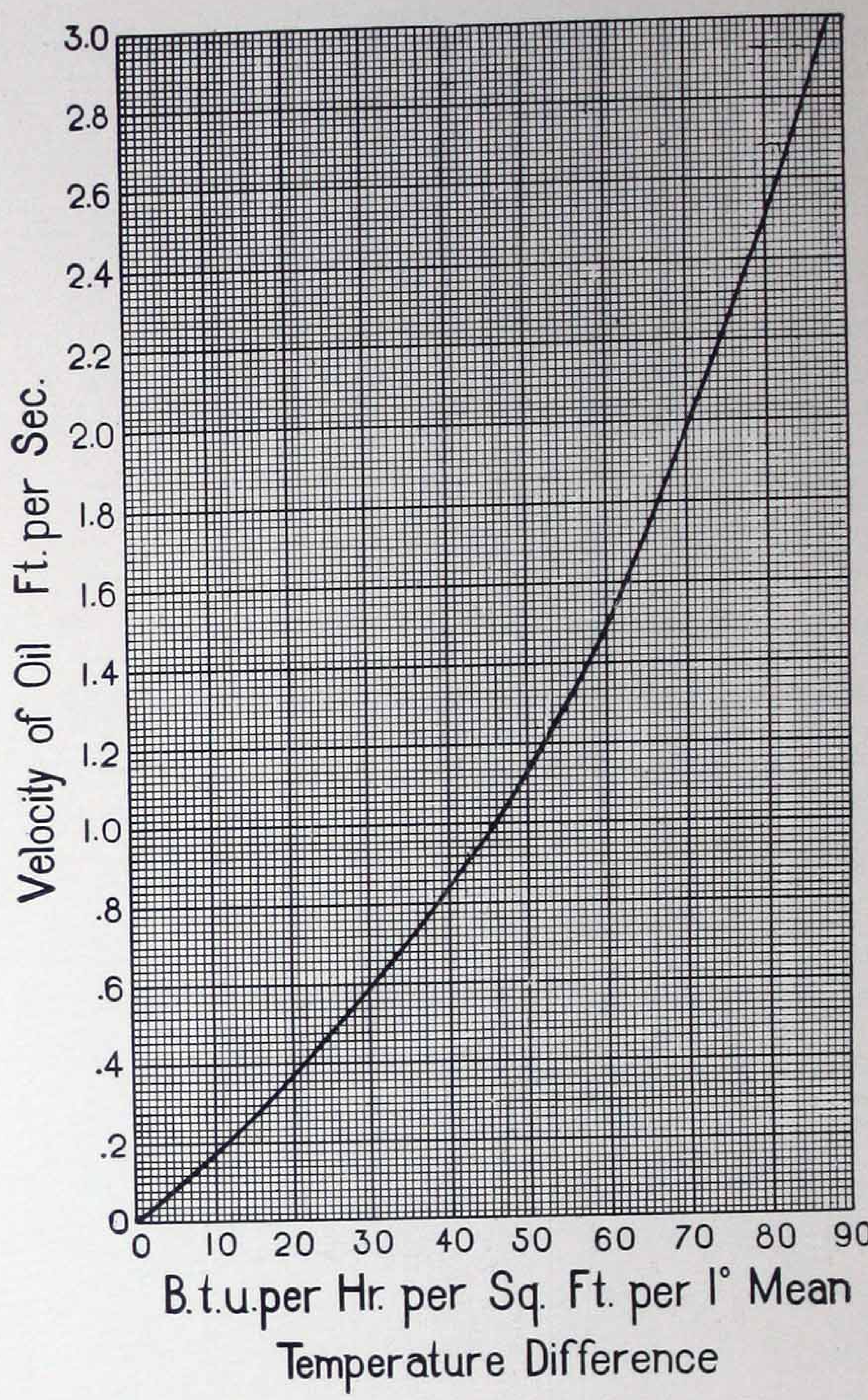


FIG. 1065-B. HEAT TRANSFER RATE DIAGRAM FOR FUEL OIL HEATER

Fig. 1065-B is a heat transfer rate diagram for the ⱪ Fuel Oil Heater described in preceding paragraphs. This chart shows the amount of heat in B. T. U. transferred per hour per square foot of heating surface for one degree mean temperature difference between the steam and the oil corresponding to various oil velocities in feet per second. Thus, for an oil flow of two feet per second, the heat transfer rate is 70 B. T. U.

₭ STRAIGHT TUBE FEED WATER HEATER

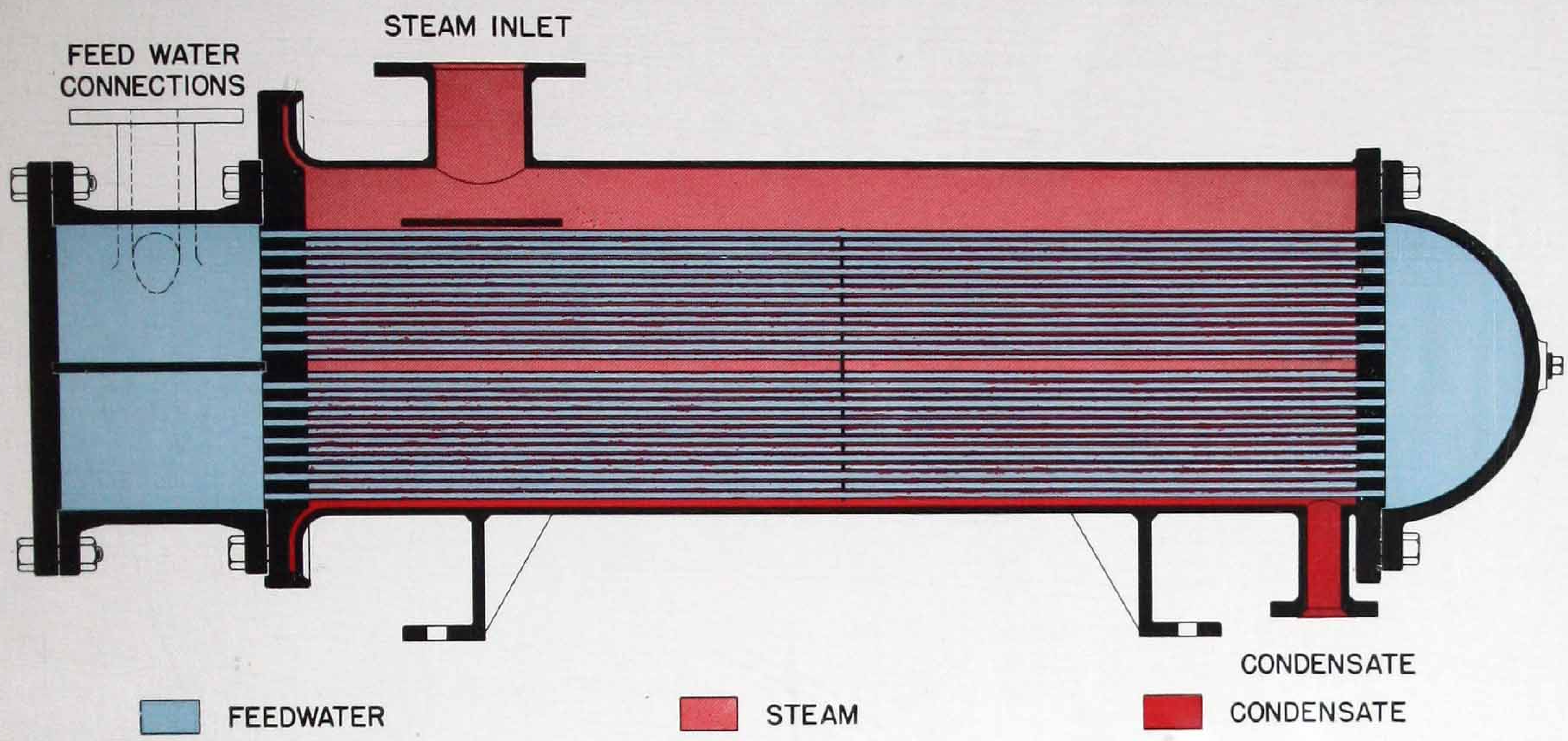


FIG. 1035. ₭ BOILER FEED WATER HEATER WITH STRAIGHT TUBES

THIS ₭ Boiler Feed Water Heater, Fig. 1035, consists of a cylindrical steel shell, to top end of which is attached a cast-iron header. Within the shell is a bundle of straight 5/8 in. seamless drawn brass or copper tubes, the ends of which are expanded into tube sheets.

The top header is divided into compartments. The cold feed water enters one of these compartments, flows through one-quarter of the tubes to the bottom header (attached to the lower tube sheet) and, after making three more passes, leaves the apparatus and flows to the steam boiler. The feed water flows through the tubes equally. The heat is transmitted rapidly and effectively; and sluggish flow, dead tubes, etc., are avoided. The pressure drop through the heater is small.

During its passage through the tube bundle the feed water is heated by the steam enveloping the tubes. The steam enters the shell near the top, and the condensate leaves through the drain at the bottom of the shell.

The headers are made tight with the tube sheets by means of a special packing that insures a tight joint, and eliminates the possibility of leakage.

The top and bottom tube sheets are rigidly attached to the shell and headers. Ample provision for expansion and contraction is provided by expansion joint in shell.

The transfer rate obtained with this heater and the very compact arrangement of the tubes result in minimum space requirements and light weight. About 2.5 to 4 sq. ft. of heating surface per 1000 lbs. per hr. of feed water are provided.

The ₭ Feed Water Heater can be used either horizontally or vertically.

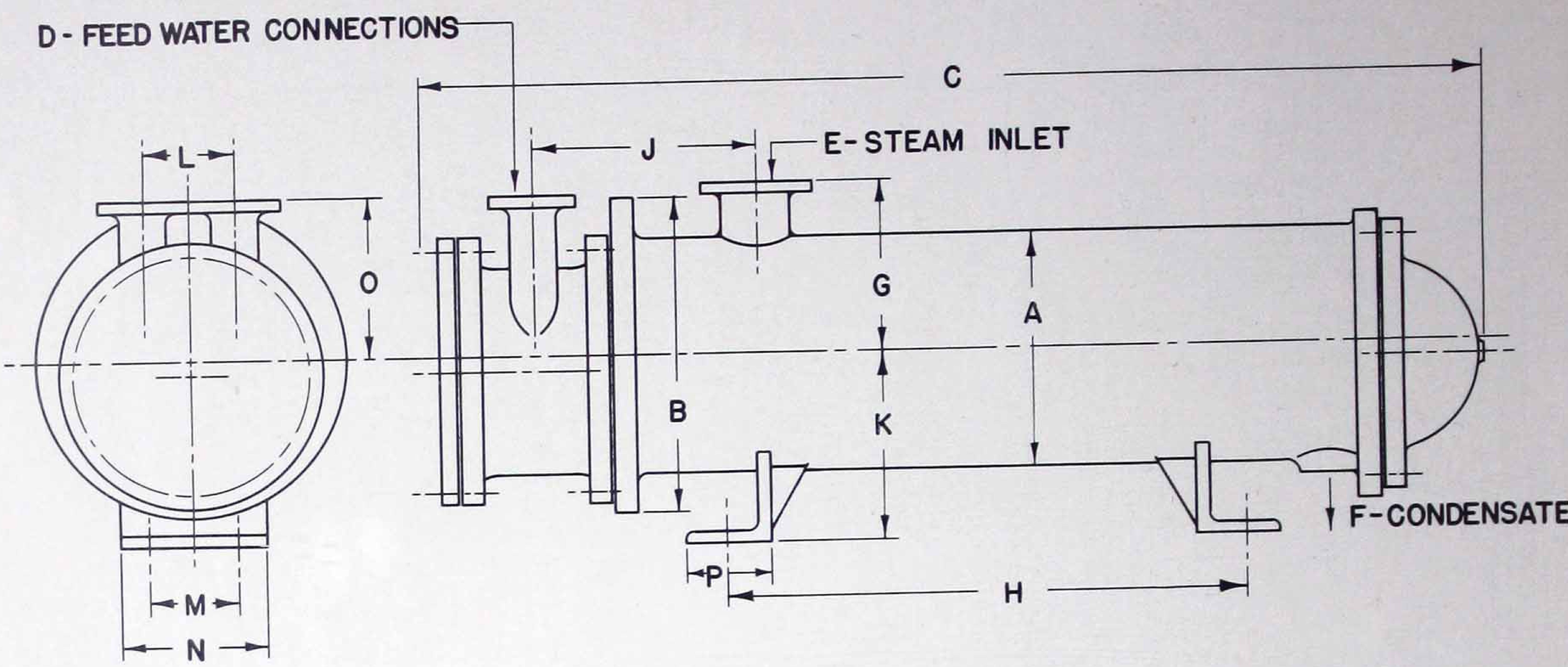


FIG. 1035-A. PRINCIPAL DIMENSIONS OF K FEED WATER HEATER

DIMENSIONS OF K FEED WATER HEATERS, FIG. 1035-A

No.	Wt. Lbs.	Dimensions in Inches, Excepting Overall Lengths (C) Which Are in Feet and Inches														
		A	B	C	D	E	F	G	H	J	K	L	M	N	O	P
1	500	8⅝	13⅛	8– 4⅝	1 (scr.)	3	1 (scr.)	8	48	24	8	4⅞	3½	6	7¼	3
2	625	9⅝	14⅛	8– 4⅞	1¼ (scr.)	3	1 (scr.)	8½	48	24	8½	5¼	4	6¾	7⅝	3
3	725	10¾	15¼	8– 5¼	1½ (scr.)	4	1¼ (scr.)	9	48	25	9	6⅛	4½	7½	8⅛	3½
4	1025	12¾	17¼	8– 5⅝	2 (scr.)	4	1¼ (scr.)	10	48	25	10	6½	5	8	9	3½
5	1125	14	18½	8– 8	2½	5	1½ (scr.)	11	48	25	11½	7½	6	9¾	9¾	4
6	1300	16	20½	8– 9⅜	3	5	1½ (scr.)	12	56	26	13½	8¼	7	11¾	10⅝	4
7	1400	16	20½	8–10½	3	6	2 (scr.)	12	56	26	13½	8¼	7	11¾	10⅝	4
8	1575	18	22½	8–11½	3	6	2 (scr.)	13	56	26	14	8¼	8	12	11⅜	4
9	1925	18	22½	8–11⅞	3	6	2 (scr.)	13	56	26	14	8¼	8	12	11½	4
10	2100	20	25	9– 1¾	4	8	2½	15	56	27	15	10	8½	13¼	12	4
11	2200	20	25	9– 1¾	4	8	2½	15	56	27	15	10	8½	13¼	12	4
12	2500	22	27	9– 3	4	8	2½	16	58	27	15½	10	10	15	13⅞	5
13	3000	24	29¾	9– 8⅛	4	8	2½	17	58	27	16	10	10	15	16½	5
14	3100	24	29¾	9– 8⅛	5	10	2½	17	58	28	16	11	10	15	16½	5

Steam and Condensate Connections 125 Lb. Std. A. S. M. E.
Feed Water Connections 250 Lb. Std. A. S. M. E.

ADVANTAGES OF HEATING FEED WATER

THE foremost advantages to be gained in heating the feed water supplied a steam boiler are decrease in fuel required for generating steam, increase in the steaming capacity of the boiler, less severe strains in the boiler shell and tubes and increase in the over-all efficiency of the plant.

If, for example, the initial temperature of the cold feed water is 60°F., and it is to be converted into steam at an absolute pressure of 150 lbs. per sq. in., that is, at 358.5°F., the total heat required per pound is the heat necessary to raise the temperature of 1 lb. of water from 60°F. to 358.5°F. plus the heat to evaporate it at 358.5°F. and boiler pressure. The latent heat is 863.2 B.t.u. Therefore the total amount of heat required is 863.2+(358.5—60)=1161.7 B.t.u. If, however, the temperature of the water is first raised to 230°F. before it is introduced into the boiler, the saving in fuel is 230—60=170 B.t.u. and the saving is 170÷1161.7, which equals .146 or 14.6%.

The net saving will be the value of this fuel less the cost of maintaining and operating the feed water heating apparatus.

The percentage saving in fuel, resulting from feed water heating with different initial temperatures of feed water, is given below in Table 1 for 100 lbs. gauge boiler pressure.

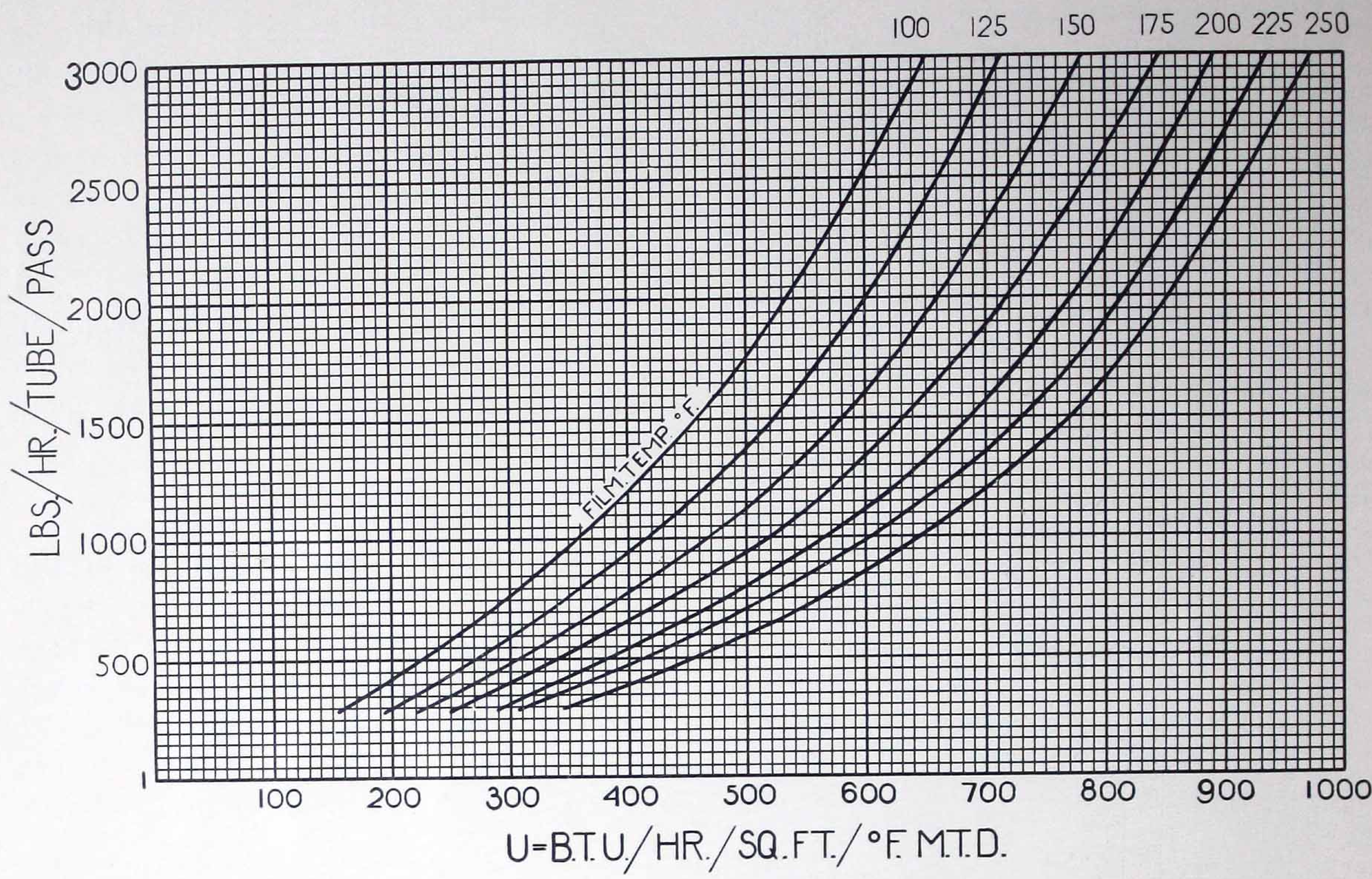
The maximum percentage saving in fuel to be obtained in heating the feed water when dry saturated steam is generated can be found by the following formula:

$$\text{Fuel saving per cent} = 100\,\frac{t_2 - t_1}{L + t_3 - t_1}$$

wherein t_1 is the initial temperature in deg. Fahr. of the feed water before heating, t_2 is the final temperature in deg. Fahr. of the feed water after heating, t_3 is temperature in degree Fahr. of the dry saturated steam at boiler pressure and L is the latent heat of steam in B. t. u. per lb. at boiler pressure and temperature.

PERCENTAGE SAVING IN FUEL BY HEATING FEED WATER WITH EXHAUST STEAM

Initial Temp. of Feed Water Deg. Fahr.	Final Temp. of Feed Water, Deg. Fahr.												Initial Temp. of Feed Water Deg. Fahr.
	120	130	140	150	160	170	180	190	200	210	220	230	
40	6.8	7.65	8.72	9.35	10.45	11.05	12.20	13.07	13.95	14.80	15.70	16.55	40
50	5.95	6.85	7.92	8.57	9.70	11.28	11.45	12.32	13.20	14.10	15.00	15.85	50
60	5.1	6.04	7.12	7.57	8.90	9.50	10.70	11.60	12.45	13.35	14.25	15.15	60
70	4.25	5.23	6.27	6.97	8.07	8.72	9.87	10.75	11.65	12.55	13.45	14.35	70
80	3.4	4.39	5.43	6.15	7.24	7.91	9.05	9.95	10.85	11.75	12.70	13.60	80
90	2.55	3.54	4.57	5.32	6.40	7.09	8.22	9.13	10.05	10.95	11.90	12.80	90
100	1.7	2.68	3.68	4.47	5.53	6.26	7.38	8.30	9.22	10.15	11.05	12.00	100
110	0.85	1.8	2.78	3.61	4.65	5.41	6.52	7.43	8.38	9.30	10.25	11.15	110
120	....	0.91	1.88	2.73	3.75	4.55	5.63	6.58	7.50	8.45	9.40	10.30	120
130	....	....	0.95	1.84	2.84	3.68	4.74	5.68	6.63	7.60	8.55	9.45	130
140	....	....	....	0.92	1.90	2.98	3.83	4.80	5.75	6.70	7.65	8.60	140
150	....	....	....	....	0.97	1.97	2.90	3.85	4.83	4.80	6.75	7.72	150



FILM TEMP.$=T_S-$(.8xM.T.D.)

T_S=SAT. STEAM TEMP. °F. M.T.D.=LOG. MEAN TEMP. DIFF. °F.

FIG. 1035-B. HEAT TRANSFER RATES FOR BOILER FEED WATER HEATER

FIG. 1035-B shows typical overall heat transfer rates (U) for steam to water thru 5/8″ OD #16 B.W.G. Muntz tubes. It shows how the rate is governed by velocity and by film temperature. Assuming the heating of water from 90°F. to 210°F. with steam at 5 lb. gauge and at a velocity of 5 ft. per second, the log. mean temperature difference would be 57.5° and the film temperature therefore 181°. The curve shows these conditions to give a rate (U) of 640.

If the water is to be heated from 150°F. to 210°F. with steam at 5 lb. gauge the log. mean temperature difference would be 39.8 and the film temperature therefore 195.2. These conditions give a rate (U) of 680.

This higher rate (680) as compared to the lower rate (640) is principally due to the lower viscosity of water at the higher temperature. A high transfer rate per unit of pressure loss is always desirable, therefore the optimum water velocity should be used and the heater designed accordingly.

METHOD OF INSTALLATION

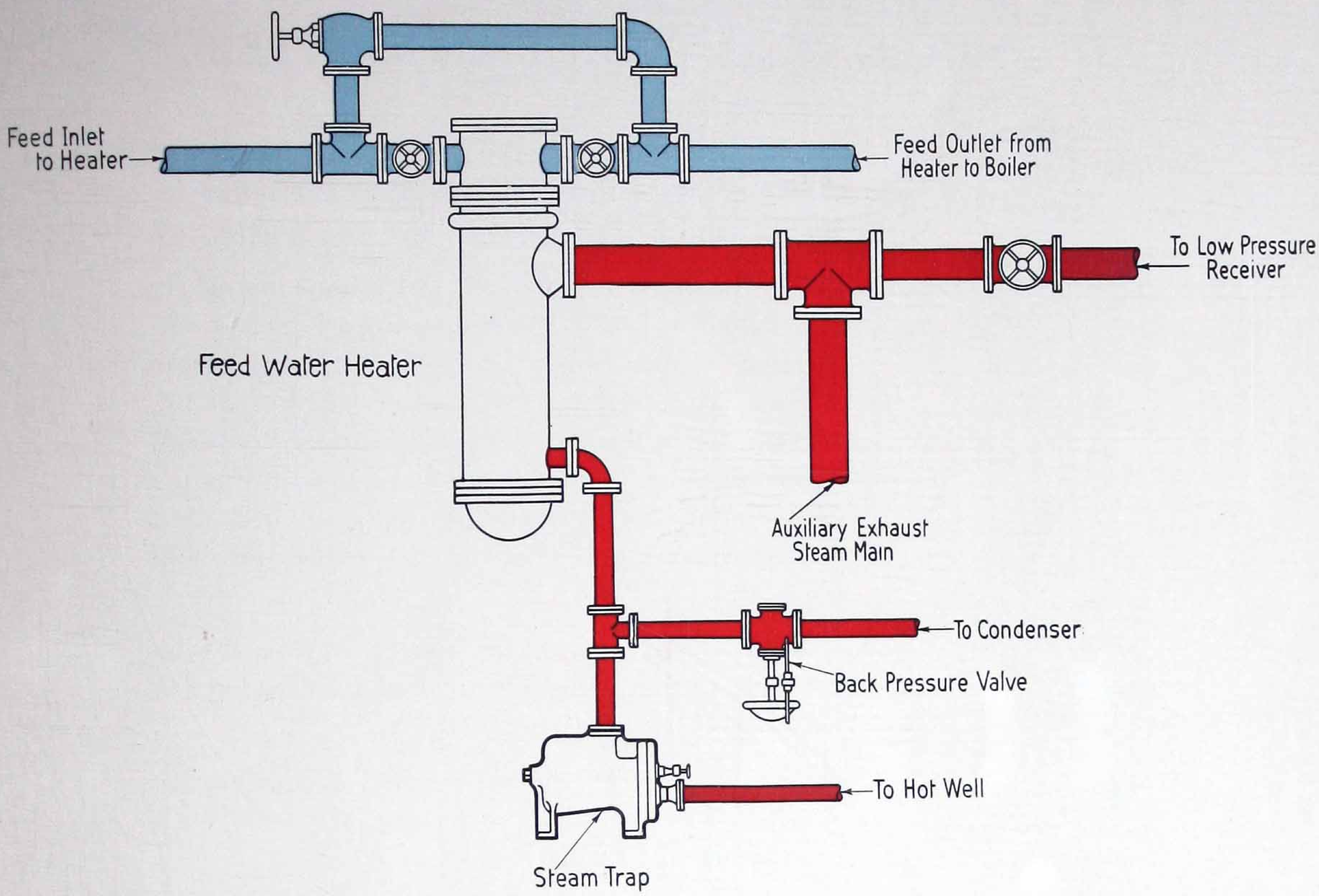


FIG. 1035-C. ARRANGEMENT OF BOILER FEED WATER HEATER INSTALLATION. Red is used for exhaust steam, blue for water

IN a typical installation of an Boiler Feed Water Heater (see Fig. 1035-C), the exhaust steam flows from the auxiliary exhaust steam main into the heater, envelopes the tubes, and leaves by way of the drain outlet whence it passes through a steam trap to the hot well. The trap is frequently by-passed. The drain outlet is also connected through an automatic back pressure valve to the condenser. This valve is set so that the desired pressure (not over 15 lbs. per sq. in.) is maintained in the heater.

The cold feed water is forced by the pumps into the heater, passed through the tubes, and thence to the boiler. The heater is generally piped with a by-pass. The by-pass is not furnished with the heater.

When specified, the heater is fitted with a pressure gauge, safety valve, vacuum breaker, thermometer, water gauge and an air vent.

As mentioned, the automatic back pressure valve maintains a uniform pressure and insures that the heater is working at its maximum capacity all the time. Should the back pressure exceed the valve setting, the valve will automatically open and allow the excess steam to flow directly to the condenser. As soon as the pressure is relieved, a compression spring closes the valve and maintains uniform conditions and maximum operating efficiency.

ꞔ CORRUGATED TUBE FILM HEATER

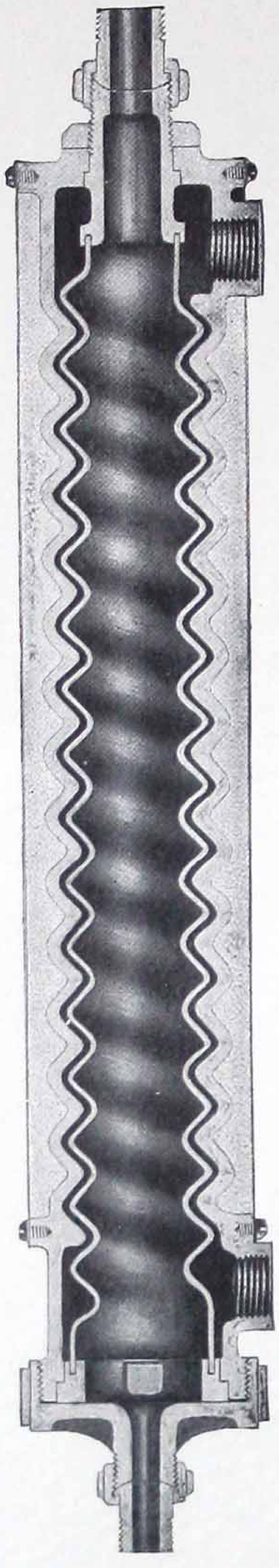


Fig. 1006

FIG. 1006 shows the ꞔ Film Heater. This heater is designed to supply instantly hot water for baths, hand basins, showers, etc.

The heater consists of an outer helically corrugated shell of cast iron surrounding a helically corrugated copper tube through which the steam passes. The feed water enters the heater at the bottom, flows through the annular space between the outer shell and inner tube, and leaves the heater at the top, thereby flowing counter-current to the steam and effecting the maximum heat transfer.

Both steam and water spaces can easily be cleaned by removing the cap and unscrewing the helically corrugated copper tube.

The exterior of the outer shell is thoroughly lagged, as shown, and the lagging protected by a planished steel casing.

No storage tanks are required. A faucet can be opened anywhere in the water system, and hot water at 140°F. withdrawn immediately at the rate of 6 gallons per minute, when the initial temperature of the heater feed water is 70°F. and the steam pressure is 75 lbs.

The total length of the heater is 26 in.; diameter 4 in.; and its weight is only 35 lbs.

The above heater can be furnished with steel tube for oil heating.

List Price Fig. 1006 .... $91.00

K CORRUGATED FILM HEATER WITH AUTOMATIC CONTROL

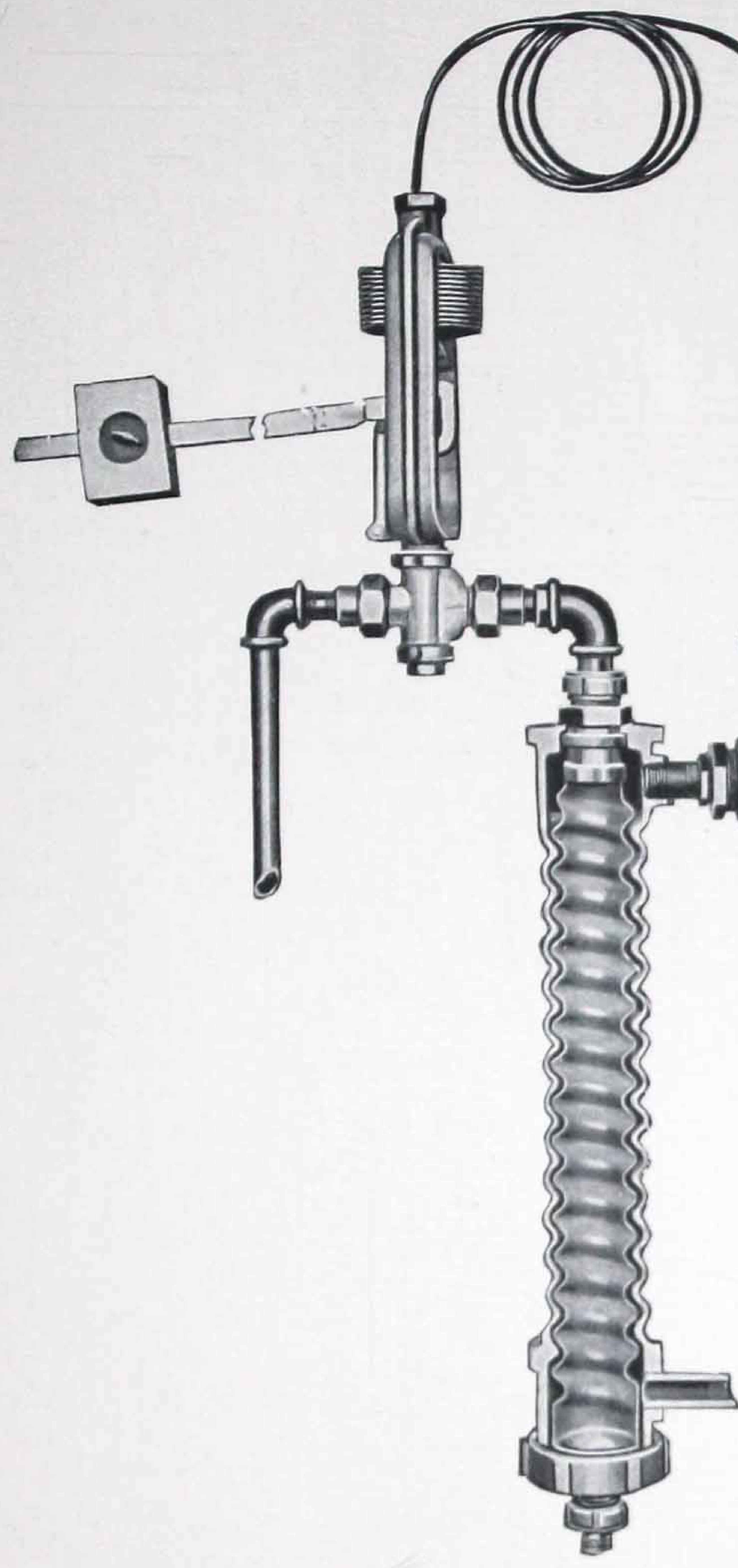


FIG. 1019. FILM HEATER WITH AUTOMATIC TEMPERATURE CONTROL

FIG. 1019 shows the K Film Heater equipped with automatic thermostatic control for the steam line.

This arrangement is recommended where an even temperature must be maintained at all times.

List Price Fig. 1019 . . . . $178.00

THE ʞ POLYCOIL FEED WATER HEATER

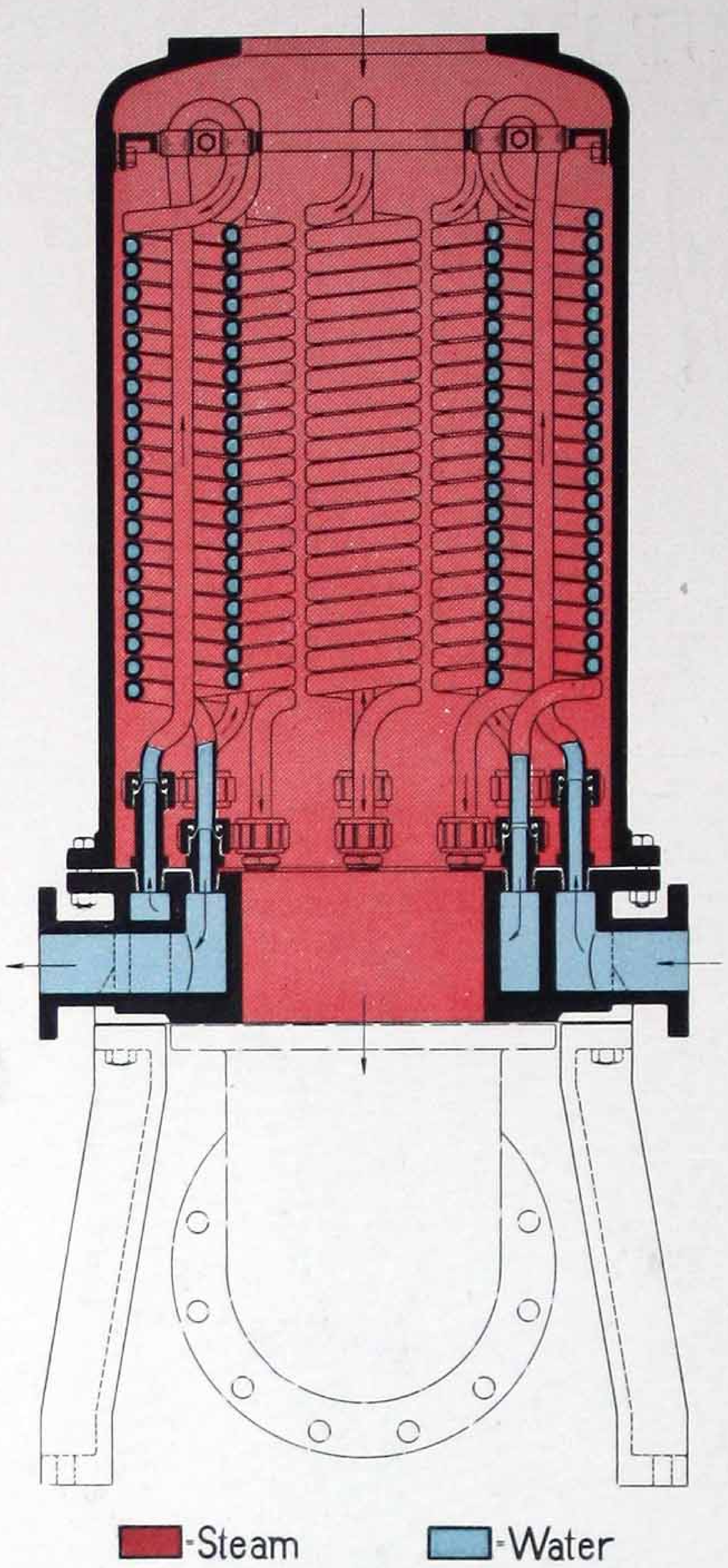


FIG. 1037. SECTIONAL VIEW OF ʞ POLYCOIL FEED WATER HEATER

THIS ʞ Heater is of the coil type, the heating surface consisting of a ring of helical coils placed vertically in a cylindrical shell and attached to a water header bolted to the bottom of the shell.

As shown in Fig. 1037 above, the shell is a vertical cylinder made of cast iron, cast steel or riveted steel plate, depending on pressure and temperature conditions specified. It is designed for working pressures up to 50 lbs. The steam inlet is at the top and steam or condensate outlet at the bottom. Steam passes downward through the body, completely surrounding the nest of coils through which the feed water passes. Ample space is provided for the steam to flow around the coils without pressure loss and this Heater can readily be installed in a steam line where only a part of the steam is needed to heat the feed water, the remainder of the steam passing on to heating system, process equipment, condenser or other auxiliaries. The Heater is provided with three supporting legs and steam usually discharges through an elbow attached to water header.